



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

AN EXAMINATION OF PROF. LEO LESQUEREUX'S
THEORY OF THE ORIGIN AND FORMATION OF
PRAIRIES.

BY O. P. HAY.

FOR many years past there has been no lack of literature on the subject of the prairies of the western states and territories, nor any dearth of theories to account for their origin. We have had their existence ascribed to fire and to water; to heat and to cold; to all sorts of phenomena and to the lack of them. The forests that once clothed these regions must have been burned up by prairie fires—before the prairies existed. They must have been drowned out by the waters of vast inland lakes that once covered these prairie states. They must have been parched up by the dryness of the climate. They must have been smothered by the impalpable fineness of the soil in which they grew. They never had an existence; because the seeds which ought to have produced them must have been ground to pomace by the glaciers of the Age of Ice, or hopelessly buried beneath their *débris*.

Prof. Leo Lesquereux, eminent in both recent and fossil botany, has published various papers on this subject, the latest of which appears in Vol. I. of the Illinois Geological Survey. In subsequent volumes of this excellent Survey this paper is frequently referred to; and certain phenomena observed in various portions of the state by the members of the survey corps, are cited as helping to establish Prof. Lesquereux's theory. As this scientific work will have a wide circulation amongst geologists; and since, on account of the high reputation of Prof. Lesquereux as a scientist, his opinions will have great weight in determining people's opinions concerning an important geological feature of the West, it is proposed in this paper to examine the grounds upon which the theory has been based, and to test its correctness. For the writer believes that the theory is insufficient to account for all the facts involved—is, indeed, opposed by many of them; and that those examples which have been cited by the geologists as confirming the theory, instead of so doing, are excellent proofs of the way in which prairies have *not* had their origin.

Prof. Lesquereux believes the failure of forest vegetation to occupy the prairies to be due to the chemical nature of the soil, coupled with, as it would seem from his language, its exceeding fineness. He believes that all our prairies and Western plains, as well as the plains of South America, Europe and Asia, have been

formed as we may now see prairies of far less extent being produced along the shores of the lakes of the West and along the banks of rivers. "Where the waves or currents strike the shores or the low grounds and there heap material, sand, pebbles, mud, etc., they build up more or less elevated dams or islands. These dams are not always built along the shores, but often enclose wide shallow basins, whose waters are thus sheltered against any movement. Here the aquatic plants, sedges, rushes, grasses, etc., soon appear, these basins become swamps, and, as it can be seen near the borders of Lake Michigan, though the waters may surround them, the trees never invade them, never grow upon them, even when the swamps become drained and dried by some natural or artificial cause." Prof. Lesquereux states that such marginal swamps, generally fringed with trees, can be seen also along the shores of Lake Erie, and along the Mississippi and Minnesota rivers, outside the line of slack water. All gradations are to be found between such swamps and dry prairies. He hence concludes that all our prairies, not only the low prairies along our lakes and rivers bottoms, but also the high rolling prairies, have been produced by the slow recess of sheets of water of various extent; that these lakes have first been transformed into swamps and by and by drained and dried. The soil of these ancient swamps, having been produced by the slow and incomplete decomposition of aquatic plants, must be of impalpable fineness and thoroughly impregnated with ulmic acid; the former condition proving deleterious to the germination of the seeds of trees, the latter condition favoring the growth of the peculiar vegetation of the prairies.

But if the prairies were at one time swamps, why is their surface not now everywhere level, or nearly so? Or, if the existing elevations have been formed as low islands or dams in lakes, why are they not now wooded? Mr. Lesquereux believes that the surface was originally horizontal; but that it has been made to assume its present undulating character by the slow and long continued erosive action of water;—in short, that the broad, gently sloping valleys have been worn out by running waters as have the beds of our rivers and creeks; the difference being that in the former case the waters have had a very gentle, in the latter a more rapid motion.

Let us now consider the facts and argument presented by Prof. Lesquereux, to sustain his opinion.

And first, is it true that trees will not, as a general thing, grow in swamps, or in ground that has once been a stagnant marsh? That there are but few species of trees that will grow in swamps covered with stagnant water none perhaps will deny; but that these same swamps will not, after they have been drained and dried, allow the growth of arborescent vegetation remains to be proved. All of Prof. Lesquereux's arguments and citations of authorities in reply to Prof. Winchell's objections to the theory of excessive moisture, cover but this one point, viz., that trees will not grow on lands saturated with stagnant water, and leave unproved the other and most important statement that they will not grow there when the ground has become dry. Should this statement be true, we ought to find extensive prairies in many regions where prairies are rare; for instance, along our low Atlantic coast, and the delta of the Mississippi River. Especially ought we to expect to find such tracts along the Amazon, instead of finding there the densest forests on the globe.

Long ago, in the *American Journal of Science*, Prof. Dana, in writing on the origin of prairies, gave the results of his own observations made in the Mohawk valley, and cited observations made by Prof. Verrill in Maine and Labrador. In this article it is stated that in Maine the bottoms of the lakes are, near the shores, composed of black, soft, vegetable mud of great depth; and though sedges and rushes are found growing at the water's edge, various kinds of trees approach very near the shore, growing even where the supporting soil is soft and wet. In cases where lakes and bogs have been drained, although grasses and sedges may get the mastery the first year or two, forest trees afterward gain the ascendancy and keep it. In Labrador, trees were found growing in peat bogs, in the very borders of lakes and pools of stagnant waters. If trees will grow in stagnant marshes and on peat bogs in Maine and Labrador and are not found growing in similar situations in the Mississippi Valley, some other explanation of the fact must be sought than the chemical nature or the fineness of the soil.

But I believe that even in the Mississippi Valley we shall have no difficulty in finding luxuriant forests in situations where, according to Prof. Lesquereux, we ought to find only prairies; nor difficulty in finding prairies where we should be led to expect to find abundant timber. The soil of the Mississippi flood-plain has been deposited as in the case of other large rivers. In some

places strong currents have washed together coarse sands and gravels; in others, where the water has had a gentle movement, it has deposited only the finest sediment; the greater portion of the bottoms, however, consists, as we might expect, of a mixture of these materials, enriched by the humus from decaying vegetation. There has been no lack of opportunities for the formation of swamps in these bottoms, which are frequently from four to eight miles or more in width. Nevertheless, on these bottom lands, formed to a great extent in the way described by Prof. Lesquereux, and much more recently than can be claimed for the higher prairies, we find the heaviest growth of timber and the greatest proportion of timber land.

In the southern part of the State, where upland prairies do not exist, the flood-plain is clothed with the densest growth of forest trees; and this almost irrespective of the character of the soil. In Alexander county, for instance, as stated in the Report of the Illinois State Geological Survey, "the bottom lands are generally flat and are interspersed with cypress ponds and marshes." The higher bottoms are said to be heavily timbered with various kinds of trees. "The swampy lands are characterized by the growth of the cypress, sweet gum, tupelo gum, cottonwood, pecan, willow, etc." We find analogous statements made concerning the counties lying northward along the Mississippi, until we reached the region where prairies begin to appear on the highlands. Then small prairies appear also on the flood-plain; but these are likely to occupy the higher grounds and the dense timber growth the low wet lands. We learn of heavy forests on soil described as a deep sandy loam, highly charged with humus; and on similar soils, bottom prairies. Nor is it unusual along the Mississippi and other rivers of Illinois to find bottom prairies whose soil contains a large proportion of sand and gravel. In the report of the geology of Jo Daviess county, the most northern river county of the State, we find this statement: "In the western part of the township of Hanover, bottom timber-land, alluvial grass-land, and a table-land, high and dry, exhibit all the characteristics of the ordinary Mississippi alluvial bottoms. Farther down in Carroll county this bottom changes into the broad, well-known sand prairie, an old, broadly extended, glittering Mississippi sand-bar." Such quotations from many independent observers could be multiplied indefinitely to show: 1st. That even marshes may be timber-grown; 2d. That the distribution of forest lands bears

no relation to that of ancient swamps; 3d. That sandy and gravelly bars and dams are frequently devoid of trees.

But even if we should grant all that Prof. Lesquereux claims respecting the inability of trees to thrive in soils that have accumulated in swamps, I cannot admit that his theory will explain the occurrence of prairies over a large part of Illinois and Iowa. However it may be in the case of Wisconsin and Minnesota, it is evident that the soil of the prairies of at least large portions of the former States has not been formed in marshes. We have, it is true, evidence that at some period since the epoch of the Drift the surface of the whole country has been depressed much below its present level. We find everywhere along the Mississippi River and at many points along the Illinois an extensive deposit capping the bluffs and sometimes extending out into the ancient river bed. This deposit is sometimes very thick near the bluffs, but thins rapidly towards the highlands and soon disappears. This deposit, called in the Report of the Illinois Survey the Loess, must have been thrown down during the Champlain epoch, when a series of lakes occupied the broad valleys of our rivers, filling them, no doubt, to their brim, and even extending over portions of the surrounding country. But that the prairie soil or subsoil was then deposited, or that there has been any general submergence since, we have, I think, no sufficient reason for believing.

On the contrary there are many serious objections that might be urged against the idea that the prairie soil has been deposited in lakes and stagnant swamps; some of which I shall here present.

1. According to Lesquereux, timber is found growing along dams cutting off from the body of the lake the bog that is to become prairie. Do we find our Illinois forests on the higher lands? That they sometimes so occur, especially in northern Illinois, will not be denied; but in such cases, instead of being long stretches of timber, bordering and separating prairies, they are generally small, rounded clumps. Much the greater part of the wooded country in Illinois is found along the river bluffs and on the bottom lands.

2. If the prairie soil is a lacustrine deposit, it ought to be free from such coarse materials as are found in the Drift. In swamps whose soil has been produced by the decay of vegetation and from sediment washed in by gently flowing waters, there is scarcely a possibility for coarse rocks and boulders to occur. The discovery of a large Drift boulder in the alluvium of the Missis

issippi river, in Whiteside county, was regarded by the observer as so extraordinary as to call for a special explanation. And yet on the prairies of Illinois, frequently lying on the surface and in the soil at all depths, are found numerous boulders of granite, syenite and trap rocks. On the surface they are found scattered from the hilltops to the very borders of the sloughs; and hidden in the ground they frequently prove a nuisance to the cultivator of the soil. Their presence in such situations cannot be reconciled with the notion that the soil is a lacustrine deposit.

3. The general absence of fossils in the soil and subsoil of the high prairie lands is opposed to Lesquereux's theory. In the Loess we find abundant fossils of land and fresh water shells. Such remains, too, sometimes occur in the deposits of the sloughs and marshes on the prairies; but these deposits are of later date than the soil of the higher grounds, and have frequently been formed as described by Lesquereux. If the prairie soil had been formed as he supposes, it would have afforded the most favorable conditions for the preservation of animal and vegetable organisms. "At a depth of from one to three feet the mosses, confervæ, and charas form a thick carpet which hardens, becomes consistent, like a kind of felt, and floating about six inches above the bottom, is nearly thick enough to sustain the weight of a man. This carpet is pierced with holes where fishes pass to and fro; and the bottom under it is that fine impalpable clay, evidently a residue of the decomposition of its plants." We ought then almost anywhere on these prairies, to find insect and leaf beds as rich as those of Cœningen. But where now are those aquatic insects that people such waters; those land and fresh water mollusks; those numerous cray-fishes; those leaves of plants that must have been buried there? Where are now those little fishes that passed to and fro through the holes in that mossy carpet? So far as the writer knows, no such remains have been found.

4. The theory urged by the distinguished botanist requires us to suppose that these prairies have undergone a greater amount of denudation than would have been possible under the conditions supposed. He admits that the prairies must originally have been horizontal, and attempts to explain their present undulating character by supposing that where we now find broad and level sloughs, the soil has been removed by the gentle movement of water on its way to lower levels. The hills, however, rise frequently many feet, sometimes perhaps a hundred, above the level of

the low grounds, and these may be many rods in width. The theory under consideration requires us to believe that in such cases an enormous amount of material has been removed. And yet it is questionable whether, under such circumstances, the soil would be removed as rapidly as it would accumulate through the decay of vegetation. For if the surface were as level as we must suppose it was, and as it frequently is in these sloughs, the water must have moved so slowly as to carry little sediment along with it; and as the water passed through the tangled grasses, rushes and sedges, even this little would have been filtered out.

Indeed, the cause assigned for the uneven surface of the prairies is one that tends to produce the very opposite effect, that of removing any inequalities of the surface that might have at first existed. For the water running down the hillsides would have carried with it some soil. On reaching the level slough its velocity would have been checked and a large part of its burden deposited. That this has occurred, rather than the contrary phenomenon, is plainly shown by the fact that the alluvium is much deeper in the sloughs than on the tops and sides of the hills.

5. The theory referred to requires us to ascribe to the alluvial deposits of the hypothetical lakes an undue thickness. For, since the peculiar fine soil of the prairies is found on the hilltops, as well as in the valleys between; it follows that, if the surface were once level, the lacustrine deposit of soil must have been of a thickness at least equal to the height of the hilltops above the lowest point to which the soil extends in the valleys. We must then believe that the deposit was perhaps a hundred feet in depth; and since the valleys have been scooped out of this, we might expect to find the hills composed entirely of the lacustrine sediment—rich, black, prairie soil from ten to one hundred feet in depth. On the contrary the soil is comparatively thin on the hilltops, very deep in the valleys.

The valleys have been excavated from the Drift formation; and the general contour of the prairies must have been determined before the prairie soil was formed, under whatever conditions it may have resulted. That some portions of the prairies, especially those bordering our great lakes and some of our rivers, have originally been swamps cannot be doubted; but that they are destitute of trees must be attributed to other causes, the absence of which in other localities permits the growth of trees alike on the finest or the coarsest, the sweetest or the sourest soil.